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# Earth Systems Science

*Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.*

## **Prepared Graduate Competencies**

The Prepared Graduate Competencies are the Preschool through Grade 12 concepts and skills that all students leaving the Colorado education system must have to ensure success in a postsecondary and workforce setting.

### **Prepared Graduate Competencies in the Earth Systems Science standard:**

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet
- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system
- Describe how humans are dependent on the diversity of resources provided by the Earth and Sun

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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

## High School Expectation

#### Concepts and skills students know include:

1. Earth's history can be inferred from evidence left from past events in the geosphere

#### Evidence Outcomes

##### Students can:

- a. Develop, communicate and justify an evidence-based scientific explanation addressing questions about Earth's history
- b. Analyze and interpret data regarding Earth's history using direct and indirect evidence

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How do we know that the earth is 4.6 billion years old?
- How did the formation of the Earth help shape its' features today?
- How can we interpret the geologic history of an area?

##### Applying Science in Society and Using Technology:

- ~~Select and use appropriate technology to help gather and analyze data, find background information and communicate scientific information on Earth's history~~
- Describe how geologic principles (e.g., original horizontality, superposition, cross-cutting relationship, unconformities, index fossils) allow us to accurately interpret geologic history
- **Employ data-collection technology such as geographic mapping systems and visualization tools to gather and analyze data and scientific information about Earth's history.**
- **Seek, evaluate and use a variety of specialized resources available from libraries, the Internet, and the community to find scientific information on Earth's history.**
- **Use locally available and web-based interactive presentation and production tools to enhance effectively organizing and communicating information about Earth's history.**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Understand that all scientific knowledge is subject to new evidence and that the presence of reproducible results yields a scientific theory</li><li>• Critically evaluate scientific claims in popular media and by peers regarding Earth’s history and determine if evidence presented is appropriate and sufficient to support the claims</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

## High School Expectation

#### Concepts and skills students know include:

2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies (eg, gravity, solar phenomena, electromagnetic radiation, impact events) which influence the planet's geosphere, atmosphere, and biosphere in a variety of ways

#### Evidence Outcomes

##### Students can:

- a. Develop, communicate and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth.
- b. Analyze and interpret data regarding extraterrestrial forces and energies
- c. Clearly identify assumptions behind conclusions regarding extraterrestrial forces and energies, in order to provide feedback on the validity of alternative explanations

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- What influences Earth's position in the universe?
- How does Earth get its energy?
- How does the electromagnetic spectrum positively and negatively impact Earth systems?

##### Applying Science in Society and Using Technology:

- Use specific **technological** equipment and **resources** to explore the universe (e.g., satellite imagery, GPS, GIS, telescopes, video and image libraries, computers)
- Understand that fusion is the most common source of energy in the universe, and it provides the basis of Earth's energy through fusion reactions in the Sun
- Describe how different types of telescopes have given us data about the universe, our galaxy, and our solar system
- **Independently and systematically use an inquiry-based process to deepen content knowledge regarding extraterrestrial forces and energies in order to connect academic learning with the real world**
- **Select and use technology tools (e.g. spreadsheet software, graphing calculator, handheld devices) to analyze and process data and report results regarding extraterrestrial forces and energies**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Understand the physical laws that govern Earth are the same physical laws that govern the rest of the Universe</li><li>• Critically evaluate models, identifying the strengths and weaknesses of the model in representing complex natural phenomena</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### High School Expectation

#### Concepts and skills students know include:

3. The theory of plate tectonics helps to explain geological, physical and geographical features of the earth

#### Evidence Outcomes

##### Students can:

- Develop, communicate and justify an evidence-based scientific explanation addressing questions surrounding plate tectonics and the geological, physical and geographical features of Earth
- Analyze and interpret data on plate tectonics and the geological, physical and geographical features of Earth
- Understand the role plate tectonics has had in respect to long-term global changes in Earth's systems, such as continental buildup, glaciations, sea-level fluctuations, and climate change
- Investigate and explain how new conceptual interpretations of data and innovative geophysical technologies led to the current theory of plate

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How do the different types of plate boundaries create different landforms on Earth?
- How have scientists "discovered" the layers of Earth?
- What drives plate motion?
- What might happen to Earth's landforms in the future?

##### Applying Science in Society and Using Technology:

- **Employ data-collection technology such as probes, handheld devices, and geographic mapping systems to gather, view, analyze, and report evidence of plate tectonics**
- Explain that new conceptual interpretations of data and innovative geophysical technologies led to the current theory of plate tectonics
- **Create own electronic learning spaces by collecting and organizing links to information resources, working collaboratively, and sharing new ideas and understandings of plate tectonics and the geological, physical and geographical features of Earth with others.**
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tectonics	<b>Nature of Science:</b> <ul style="list-style-type: none"><li>• Understand that all scientific knowledge is subject to new findings and that the presence of reproducible results yields a scientific theory</li><li>• Formulate testable, falsifiable inquiry questions about plate tectonics and design a method to find an answer</li><li>• Share experimental data and respectfully discuss conflicting results</li><li>• Recognize the current understandings of plate tectonics has developed over time and has become more sophisticated as new technologies have lead to new evidence</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### High School Expectation

#### Concepts and skills students know include:

4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere

#### Evidence Outcomes

##### Students can:

- Develop, communicate, and justify an evidence-based scientific explanation that shows climate is a result of energy transfer among the atmosphere, hydrosphere, geosphere and biosphere.
- Analyze and interpret data on Earth's climate
- Demonstrate how different factors determine a location's climate (e.g., Earth's tilt, seasons, geophysical location, proximity to oceans, landmass location, latitude, elevation, etc.)
- Identify mechanisms in the past and present that have changed earth's climate
- Analyze the evidence and assumptions regarding climate change

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How can changes in the ocean create climate change?
- How is climate influenced by changes in Earth's energy balance?
- How have climates changed over Earth's history?
- How does climate change impact all of Earth's systems?
- How have climate changes impacted human society?

##### Applying Science in Society and Using Technology:

- Recognize that much of the data we receive about the ocean and the atmosphere is from satellites
- Interpret evidence from weather stations, buoys, satellites, radars, ice and ocean sediment cores, tree rings, cave deposits, native knowledge and other sources in relation to climate change
- Investigate and explain how humans are impacting Earth's climate
- **Use web-based and other technology tools to show connections and patterns in weather and climate data**
- **Address real-world climate change problems and issues by using information and communication technology tools to gather, evaluate, and use information from different sources, analyze findings, draw conclusions, and create solutions.**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Understand how observations, experiments and theory used to construct and refine computer models</li><li>• Examine how computer models are used in predicting the impacts of climate change</li><li>• Critically evaluate scientific claims in popular media and by peers regarding climate and climate change and determine if the evidence presented is appropriate and sufficient to support the claims</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe how humans are dependent on the diversity of resources provided by the Earth and Sun

## High School Expectation

#### Concepts and skills students know include:

5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and non-renewable resources

#### Evidence Outcomes

##### Students can:

- a. Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development and consumption of renewable and non-renewable resources
- b. Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere and biosphere in regards to resource use

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How do humans use resources?
- How can humans reduce the impact of resource use?
- How are resources used within our community?
- What are the advantages and disadvantages of using different types of energy?

##### Applying Science in Society and Using Technology:

- Seek, evaluate and use a variety of specialized resources available from libraries, the Internet, and the community to identify the impact of various technologies on how resources are located, extracted and consumed
- Recognize that technology development has reduced the pollution, waste and ecosystem degradation caused by extraction and use
- Employ a variety of digital environments and media in order to interact and collaborate with peers, experts and others to develop and publish a plan to reduce environmental impacts due to resource consumption
- Select and use technology tools (e.g. spreadsheet software, graphing calculator, handheld devices) to analyze and interpret data about the effect of resource consumption and development on resource reserves to draw conclusions about sustainable use

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Clearly identify assumptions behind emotional, political and data driven conclusions about renewable and non-renewable resource use</li><li>• Critically evaluate scientific claims in popular media and by peers regarding and determine if evidence presented is appropriate and sufficient to support the claims</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### High School Expectation

#### Concepts and skills students know include:

6. The interaction of Earth's surface with water, air, gravity, and biological activity cause physical and chemical changes

#### Evidence Outcomes

##### Students can:

- Develop, communicate and justify an evidence-based scientific explanation addressing questions regarding the interaction of Earth's surface with water, air, gravity and biological activity
- Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity and biological activity create
- Evaluate negative and positive consequences of physical and chemical changes on the geosphere

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How do Earth systems interact to create new landforms?
- What are positive changes on Earth's geosphere due to water, air, gravity and biological activity?
- What are negative changes on Earth's geosphere due to water, air, gravity and biological activity?

##### Applying Science in Society and Using Technology:

- Use remote sensing and GIS data to interpret landforms and landform impact on human activity
- Use geologic, physical and topographic maps to interpret surface features
- Recognize that landform models help us understand the interaction among Earth systems
- **Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media to explore the impact of human activity and agricultural practices on soil formation and soil loss**
- **Employ data-collection technology such as probes, handheld devices, and sensors to gather, view, analyze, and interpret data about chemical and physical changes that water, air, gravity and biological activity create**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Formulate testable, falsifiable inquiry questions about physical and chemical changes on the geosphere and design a method to find an answer</li><li>• Share experimental data and respectfully discuss conflicting results</li><li>• Students can select and use appropriate technology to help gather and analyze data, find background information and communicate scientific information on physical and chemical changes</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### High School Expectation

#### Concepts and skills students know include:

7. Natural hazards have local, national and global impacts (volcanoes, earthquakes, tsunamis, hurricanes, thunderstorms, etc.)

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ul style="list-style-type: none"> <li>a. Develop, communicate and justify an evidence-based scientific explanation addressing questions regarding natural hazards and their local, national and global impacts</li> <li>b. Analyze and interpret data about natural hazards, using direct and indirect evidence</li> <li>c. Make predictions and draw conclusions about the impact of natural hazards on human activity – locally, nationally and globally</li> </ul>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>• Why are some natural hazards difficult to predict, while others are easier to predict?</li> <li>• How are humans impacted by natural hazards?</li> <li>• How can we prepare for natural hazards?</li> <li>• How is climate change expected to change the incidence of natural hazards?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>• <b>Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media in order to research and explain how to build safe structures in earthquake, hurricane, tsunami, or tornado zones</b></li> <li>• Identify that differing technologies are used to study different types of natural hazards</li> <li>• Explain how natural hazard zones affect construction or explain why monitoring natural hazards is important (i.e. air traffic safety, evacuations, protecting property, etc.)</li> <li>• Describe how science is used by disaster planners, working with the scientific community, to come up with diverse ways to mitigate the impacts of natural hazards on the human population and on a given ecosystem</li> <li>• <b>Address a real-world natural hazard issue in the local community by using information and communication technology tools to gather, evaluate, and use information from different sources, analyze findings, draw conclusions, and create solutions.</b></li> </ul>

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Use digital media and environments to communicate and work collaboratively, including at a distance, with local, national and global organizations to report and review natural disaster data., comparing their conclusion to others posed by other scientists (alternate explanations)</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Eighth Grade Expectation

#### Concepts and skills students know include:

1. Weather is a result of complex interactions of Earth's atmosphere, both land and water driven, by energy from the sun that can be predicted and described through complex models

#### Evidence Outcomes

##### Students can:

- a. Differentiate between basic and severe weather conditions, and develop an appropriate action plan for personal safety and the safety of others
- b. Observe and gather data for various weather conditions then analyze the data and explain the results
- c. Use models to develop and communicate a weather prediction

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- Why does weather vary from day to day?
- What are the strengths and limitations of different types of weather models?
- What are the variables that make predicting weather challenging?
- How do weather patterns relate to climate?

##### Applying Science in Society and Using Technology:

- ~~Select and use appropriate technology to help gather data, analyze data or find background information on this topic and communicate your findings~~
- Recognize that weather stations, buoys, satellites, radar, and computer modeling are examples of technology used to help forecast weather
- **Use technology resources such as online encyclopedias, online databases, and credible websites to locate information to** research the complicated process of weather prediction and the interaction of many variables it is based on
- Explain how weather prediction can save lives, protect property and conserve resources
- **Employ data-collection technology such as probes, sensors and handheld devices to gather, view, analyze, and report results for scientific investigations about weather**
- **Select and use technology tools (e.g. graphing software, calculator, handheld devices) to analyze and process data and report results**

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	<b>Nature of Science:</b> <ul style="list-style-type: none"><li>• Evaluate of the accuracy of various tools used in forecasting weather</li><li>• Consider the historical context and impact of early weather research and the potential implications for current weather studies on science and our society</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Eighth Grade Expectation

#### Concepts and skills students know include:

2. Earth has a variety of climates defined by average temperature, precipitation, humidity, air pressure, and wind that have changed over time in a particular place/location

#### Evidence Outcomes

##### Students can:

- a. Develop, and communicate an evidence based scientific explanation to account for Earth's different climates
- b. Research and evaluate direct and indirect evidence to explain how climates vary from one location to another on Earth

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How does the climate in one area compare and contrast with another area?
- Why are there different climates on Earth?
- How has Earth's climate changed over time?
- What evidence supports human influence on climate change?
- What is the difference between weather and climate?

##### Applying Science in Society and Using Technology:

- Use data tables, charts and graphs to compare and contrast various climates around the globe
- Use computer models help understand past, present and future climates
- Use interactive tools and social media to communicate remotely with peers, experts, and others about how climates vary from one location to another on Earth
- Select and use technology tools (e.g. spreadsheet software, graphing calculator, handheld devices) to analyze and process data and report results.

##### Nature of Science:

- Formulate testable, falsifiable inquiry questions about earth's climate and design a method to find an answer
- Describe various techniques that scientists use to study climate, and suggest ways that each technique can be used to better understand various climates and changes in climate

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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Understand the Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

### Eighth Grade Expectation

#### Concepts and skills students know include:

3. The relative positions and motions, of Earth, Moon, and Sun can be used to explain observable effects from Earth (e.g., seasons, eclipses, moon phases)

#### Evidence Outcomes

##### Students can:

- a. Develop, communicate and justify an evidence-based explanation, using relative positions of the Earth, Moon and Sun, for each of the following natural phenomenon:
  1. Tides
  2. Eclipses of the Sun and Moon
  3. Different shapes of the Moon as viewed from Earth
- b. Analyze and interpret data to explain why we have seasons

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- Why do we observe changes in the relative positions of the Earth, Moon, and Sun from Earth over time?
- How does the relative positions of the Earth, Moon and Sun affect natural phenomenon on Earth?

##### Applying Science in Society and Using Technology:

- Use computer simulation models to explain the relative motions of Earth, Moon and Sun over time.
- Describe how different tools are used to help understand motion in the Solar System
- Describe how space missions can be planned because we understand planetary motion
- Recognize that the GPS system is based on relative motion and has many applications to human endeavors
- Use web-based and other technology tools to show connections and patterns in data and information collected about Earth, Moon and Sun positions
- Paying attention to copyright provisions, work collaboratively or individually to import and manipulate pictures, images, and charts in documents, spreadsheets, presentations, Web pages, or other creative products and presentations that effectively communicate an evidence based explanation about natural phenomenon related to Earth, Moon and Sun positions.

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Understand there are interrelationships among science, technology and human activity have global consequences</li><li>• Evaluate visual and print media for scientific evidence, bias, and conjecture related to the relative positions of the Earth, Moon and Sun</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

### Seventh Grade Expectation

#### Concepts and skills students know include:

1. The Solar System is comprised of various objects that orbit the Sun. These bodies can be classified based on their characteristics

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ol style="list-style-type: none"> <li>a. Construct a scale model of the Solar System and use it to explain the motion of objects in the system (planets, Sun, moons, asteroids, comets, dwarf planets) in the Solar System</li> <li>b. Describe methods and equipment used to explore the Solar System and beyond.</li> <li>c. Design a data collecting investigation that involves direct observation of objects in the sky then analyze and explain your results</li> <li>d. Research, critique and communicate scientific theories that explain how the Solar System was formed</li> </ol>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>• How are the various bodies in the Solar System similar and different?</li> <li>• How does investigating characteristics of the various bodies in the Solar System provide clues to Earth's origin and evolution?</li> <li>• Why do objects stay in orbit (satellites, moons, planets...)?</li> <li>• How is the life cycle of a star such as our Sun similar to the cycle of life on Earth?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>• Explore the methods and equipment used to investigate far away objects like those in the Solar System and beyond</li> <li>• Use computer data sets and simulations to explore objects in the Solar System</li> <li>• Recognize that mathematical models are used to predict orbital paths and events</li> <li>• Use web-based and other technology tools to show connections and patterns in astronomical observations, data and information</li> <li>• Use technology resources such as online encyclopedias, online databases, and credible websites in order to evaluate information about different scientific theories that explain how the Solar System was formed.</li> </ul>

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Understand that scientists work from the assumption that the universe is a single system in which the basic rules are the same everywhere, e.g., planets follow the same rules about forces as other objects</li><li>• Recognize that our current understandings about the solar system has developed over centuries of studies by many scientists, and that through continued scientific investigations and advances in data collection we will continue to refine our understandings of the solar system</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Understand the earth is a complex system of interactions between the geosphere, atmosphere, hydrosphere and biosphere

## Seventh Grade Expectation

#### Concepts and skills students know include:

2. Major geological events such as earthquakes, volcanic eruptions, and mountain building are associated with plate boundaries and attributed to plate motions

#### Evidence Outcomes

##### Students can:

- a. Gather, analyze and communicate data, which explains Earth's plates, plate motions and the results of plate motions
- b. Identify, interpret and explain models of Earth's plates' motions

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How can major geological events be attributed to plate movement?
- What evidence supports the theory of plate tectonics?
- What are the effects of plate movement along plate boundaries?

##### Applying Science in Society and Using Technology:

- Recognize that computer models and simulations help us understand and make informed decisions about major geological events
- Recognize that building codes and emergency plans are affected by natural threats in an area
- Use maps to locate geologic "hot spots", earthquakes and volcanic activity
- Use web-based and other technology tools to show connections and patterns in data and information collected about tectonic plate boundaries and earthquakes, volcanic eruptions, and mountain building
- Use interactive technology tools to participate as a group in analyzing and organizing information.

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Construct a model to explain how plate movement results in geologic events</li><li>• Trace the development of a scientific theory using the theory of plate tectonics</li><li>• Describe the ethical traditions of science: value peer review, truthful reporting of methods and outcomes, making work public, and sharing a lens of professional skepticism when reviewing others work</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

### Seventh Grade Expectation

#### Concepts and skills students know include:

3. Geologic time, history, and changing life forms are indicated by fossils and successive sedimentation, folding, faulting and uplifting of layers of sedimentary rock

#### Evidence Outcomes

##### Students can:

- a. Describe the geologic time scale and why it is used
- b. Identify and describe the impact of major geological events on life on Earth
- c. Identify and describe major events in Earth's geologic history
- d. Use direct and indirect evidence to determine sequence of events in geologic time

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How can we interpret data from layers of rock?
- What is geologic time?

##### Applying Science in Society and Using Technology:

- Consider how knowledge of Earth's structure helps humans locate and extract resources
- Recognize how dating fossils absolutely, and relatively, helps assemble the story of the evolution of life on Earth
- **Select and use grade-level appropriate electronic reference materials and pre-selected Internet sites to research and explain the impact of major geological events on life on Earth**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Formulate testable, falsifiable inquiry questions on the history of the earth and design a method to find an answer</li><li>• Describe how scientists study fossils and suggest ways that understanding fossil evidence contributed to our knowledge about life on Earth over geologic time</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Sixth Grade Expectation

#### Concepts and skills students know include:

1. Complex interrelationships exist between Earth's structure, and natural processes over time that are constructive and destructive

#### Evidence Outcomes

##### Students can:

- a. Gather, analyze and communicate an evidence based explanation for the complex interaction between Earth's constructive and destructive forces
- b. Gather, analyze and communicate evidence that explains the formation of Earth's surface features

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How do forces inside the Earth and on the surface build, destroy and change Earth's crust?
- How does Earth's surface change over time?

##### Applying Science in Society and Using Technology:

- Use technology resources such as online encyclopedias, online databases, and credible websites to locate information about the benefits/ costs of building in areas prone to, changes resulting from constructive and destructive forces such as earthquakes, landslide, etc.
- Use or create a computer simulation for Earth's changing crust.
- Use web-based and other technology tools to show connections and patterns in data and information collected about tectonic plate boundaries and earthquakes, volcanic eruptions, and mountain building

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	<b>Nature of Science:</b> <ul style="list-style-type: none"><li>Practice the collaborative inquiry process that scientists use to identify local evidence of Earth’s constructive and destructive processes</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe how humans are dependent on the diversity of resources provided by the Earth and Sun

## Sixth Grade Expectation

#### Concepts and skills students know include:

2. Water on Earth is distributed and circulated through oceans; glaciers, rivers, ground water; and the atmosphere

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ol style="list-style-type: none"> <li>Gather and analyze data to account for local and world-wide water circulation and distribution patterns</li> <li>Model how water is transferred throughout the earth using various forms of evidence</li> <li>Identify problems and propose solutions related to water quality, circulation and distribution, both locally and worldwide</li> <li>Identify the various causes and effects of water pollution in local and world water distributions</li> </ol>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>How is water cycled on Earth?</li> <li>How does the lack of water (or abundance) impact human civilizations and populations?</li> <li>How do your daily decisions impact the quality of water in the water cycle?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>Analyze home water quality and consumption</li> <li>Explain how water systems affect local, regional and world development</li> <li>Select and use technology tools (e.g. chart maker in spreadsheet, calculator, graphing software) to analyze water use patterns in Colorado and how these effect development in the state</li> <li>Describe where water goes after you use it in your house</li> <li>Gather water use data, examine patterns, and apply that information for decision making using digital tools and resources.</li> </ul>

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Formulate testable, falsifiable research questions about water distribution</li><li>• Critically evaluate models, identifying the strengths and weaknesses of the model in representing complex natural phenomena</li><li>• Reflect on and describe their work in class as it compares to the practice of professional scientists</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe how humans are dependent on the diversity of resources provided by the Earth and Sun

### Sixth Grade Expectation

#### Concepts and skills students know include:

3. Earth's natural resources provide the foundation for all of the physical needs of human society. Many of these resources are non-renewable on human time scales while others can be renewed or recycled

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ol style="list-style-type: none"> <li>a. Research and evaluate data and information to learn about the types and availability of various natural resources and use this knowledge to made evidence based decisions</li> <li>b. Identify and evaluate types and availability of renewable and non-renewable resources</li> <li>c. Use direct and indirect evidence to determine the types of resources and their applications used in your community</li> <li>d. Research and critically evaluate data and information to learn about the advantages and disadvantages of using fossil fuels and alternative energy sources</li> </ol>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>• What resources are found and used in our community?</li> <li>• How can natural resources be identified and classified?</li> <li>• How can we make responsible choices about the resources we use on a daily basis?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>• Recognize that natural resources come from a variety of locations and have to be mined or harvested depending on the type</li> <li>• Recognize that a resource can be used in a variety of ways depending on the product being made (plastics, textiles, medications and fertilizers are produced from petroleum).</li> <li>• <b>Seek and use a variety of specialized resources available from libraries, the Internet, and the community in order to</b> explain how resources in Colorado directly affect the state economy and society by providing employment and sources of revenue</li> <li>• <b>Recognize bias in print and digital resources while reading about resource issues with guidance from the teacher.</b></li> <li>• <b>Use interactive tools and social media to communicate with peers, experts, and others about responsible use of renewable and non-renewable resources.</b></li> </ul>

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Recognize and describe the ethical traditions of science: value peer review, truthful reporting of methods and outcomes, making work public, and sharing a lens of professional skepticism when reviewing others work</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Describe how humans are dependent on the diversity of resources provided by the Earth and Sun.

### Fifth Grade Expectation

#### Concepts and skills students know include:

1. Earth and Sun provide a diversity of renewable and nonrenewable resources.

#### Evidence Outcomes

##### Students can:

- Develop, communicate and justify a scientific explanation addressing a scientifically oriented question of local relevance around one or more resources generated by the sun or Earth
- Analyze and interpret a variety of data to understand the origin, utilization, and concerns associated with natural resources

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How can the Sun be used as an energy source?
- How can wind be used as an energy source?
- What types of energy sources exist in Earth?

##### Applying Science in Society and Using Technology:

- Describe how mining operations provide non-renewable resources
- Identify that resources are not distributed evenly and require transportation systems to move them to where they are needed
- Discuss how towns and laws are often built around resource extraction
- **Develop projects with peers addressing a scientifically oriented question of local relevance around one or more resources generated by the sun or Earth that can be shared electronically and can challenge other students to answer questions or give opinions adding to the content**

##### Nature of Science:

- Review and analyze scientific explanations about natural resources presented by their peers, providing feedback to push their peers to be scientifically accurate and base their claims on adequate and reasonable scientific evidence, not opinion
- Earth and Sun provide a variety of resources some are renewable and some are not

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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Fifth Grade Expectation

#### Concepts and skills students know include:

2. Earth's surface is constantly changing through a variety of processes and forces

#### Evidence Outcomes

##### Students can:

- Develop, justify, and communicate an evidence based scientific explanation around one or more factors that change Earth's surface
- Analyze and interpret data identifying ways Earth's surface is constantly changing through a variety of processes and forces (e.g., plate tectonics, erosion, deposition, solar influences, climate, human activity, and so forth)

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- How does Earth's surface change?
- How do changes on Earth's surface impact humans?

##### Applying Science in Society and Using Technology:

- Develop an awareness of the benefits and dangers to humans as Earth's surface constantly changes
- Describe ways that communities take into account the effects of the changing Earth: springs, stilts, drainage, frost heaving
- Recognize that some cities have emergency plans for earthquakes, flooding, eruptions, and tornadoes
- Understand that the development of technology led to tools that made the establishment of measurement standards possible (the Richter Scale)
- **Select and use technology tools (e.g. chart maker in spreadsheet, calculator, graphing software) to analyze and process data about Earth processes**

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Formulate testable, falsifiable research questions about how the earth surface changes</li><li>• Utilize a variety of media sources to collect and analyze data around Earth processes and the changing surface</li><li>• Assess and provide feedback on other’s scientific explanations about factors that change Earth’s surface</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Fifth Grade Expectation

#### Concepts and skills students know include:

3. Weather conditions change because of the uneven heating of Earth's surface by the Sun's energy. Weather changes are measured by differences in temperature, air pressure, wind and water in the atmosphere and type of precipitation

#### Evidence Outcomes

##### Students can:

- Develop, justify, and communicate an evidence based scientific explanation for changes in weather conditions
- Gather, analyze and interpret data such as temperature, air pressure, wind, and humidity in relation to daily weather conditions
- Describe weather conditions based on data collected using a variety of weather tools
- Share their reasoning on how they came to conclusions based on the evidence and their understanding of how weather conditions change

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- Why does the Sun heat different surfaces at different rates?
- Why does the weather change from day to day?

##### Applying Science in Society and Using Technology:

- Recognize that the Sun's energy helps to change our weather daily by influencing the water cycle, air movement and temperature
- Explain how gliders and birds exploit updrafts created by thermals
- Understand that deicing planes in winter is sometimes necessary so that they can fly
- Explore how weather satellites generate data that measures and monitors changes in weather
- Use data collection tools and measuring devices to gather, organize, and analyze data such as temperature, air pressure, wind, and humidity in relation to daily weather conditions
- Select and use technology tools (e.g. chart maker in spreadsheet, calculator, graphing software) to analyze and process data and report results.

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Assess and provide feedback on other’s scientific explanations about weather, pushing for reasoning based on evidence and scientific principles</li><li>• Understand how weather maps are utilized to predict the weather from day to day</li></ul>
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## **Content Area: Science**

### **Standard: Earth Systems Science**

#### **Prepared Graduate Competencies:**

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

### **Fourth Grade Expectation**

#### **Concepts and skills students know include:**

1. Earth is part of our solar system which includes the Sun, Moon, and other bodies that orbit the sun in predictable patterns. These patterns lead to observable paths of objects in the sky as seen from Earth

#### **Evidence Outcomes**

##### **Students can:**

- a. Develop, communicate and justify a scientific explanation addressing a scientifically oriented question about the components of the solar system
- b. Gather, analyze and interpret data about components of the solar system
- c. Utilize direct and indirect evidence to investigate the components of the solar system
- d. Gather, analyze, and interpret data about the sun rise and set, and moon movements and phases

#### **21<sup>st</sup> Century Skills and Readiness Competencies**

##### **Inquiry:**

- What are the patterns of movement for Sun and Moon across the sky?
- How does the Earth compare to other objects orbiting the Sun?
- How do we study the solar system?

##### **Applying Science in Society and Using Technology:**

- Recognize that space exploration has produced data to answer questions about our solar system
- Use a variety of technology sources and applications to investigate and communicate about our solar system
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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Examine how space exploration has produced data to answer questions about our solar system</li><li>• Collaborate to design, conduct and communicate results of an investigation around components of our solar system</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Third Grade Expectation

#### Concepts and skills students know include:

1. Earth's materials can be broken down and/or combined into different materials (e.g., rocks and minerals, rock cycle, formation of soil, sand). Some of these materials are usable resources for human activity

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ol style="list-style-type: none"> <li>a. Investigate and identify two or more ways Earth's materials can be broken down and/or combined in different ways (e.g., minerals into rocks, rock cycle, formation of soil, sand)</li> <li>b. Develop an evidence-based, scientific explanation around one or more processes that brake down and/or combine Earth materials</li> </ol>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>• What are some of the ways that Earth's materials are formed?</li> <li>• Where do these different Earth materials (e.g., soil, sand, rocks, oil) come from? What is the process and materials by which they were formed?</li> <li>• How is Earth's surface changing?</li> <li>• How do rocks "cycle"?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>• Recognize that many of Earth's materials are usable resources for building or energy</li> <li>• Recognize the process and time (rates) required for various materials to be formed (e.g., fossil fuels, soils) and the implications of human use of these resources</li> <li>• Utilize a variety of media sources to collect and analyze data around Earth materials and the processes by which they are formed</li> <li>• With teacher guidance, use technology tools to create and present ideas about Earth processes (e.g. podcasts, simple slide show)</li> </ul>

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	<p><b>Nature of Science:</b></p> <ul style="list-style-type: none"><li>• Formulate testable questions about the composition and formation of rocks</li><li>• Use models to demonstrate the rock cycle or what other ways Earth materials are broken down or combined</li></ul>
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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Second Grade Expectation

#### Concepts and skills students know include:

1. Weather and the changing seasons impact organisms (e.g. humans, plants, other animals) and the environment

Evidence Outcomes	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>Students can:</b></p> <ul style="list-style-type: none"> <li>a. Develop and communicate an evidence based scientific explanation for how the weather and changing seasons impacts the organisms (e.g. humans, plants, other animals) and the environment</li> <li>b. Analyze and interpret data such as temperatures in different locations (sun/shade), at different times and different seasons as evidence of how organisms and the environment are influenced by the weather and changing seasons</li> </ul>	<p><b>Inquiry:</b></p> <ul style="list-style-type: none"> <li>• Does the temperature change at different times during the day (morning, noon, evening) and from day to day?</li> <li>• What changes do we make in our daily lives based on changes in the weather?</li> <li>• What are the weather patterns that happen during different seasons (fall, winter, spring, summer)?</li> </ul> <p><b>Applying Science in Society and Using Technology:</b></p> <ul style="list-style-type: none"> <li>• Develop and communicate an evidence based scientific explanation for how the weather and changing seasons impacts organisms (e.g. humans, plants, other animals) and the environment</li> <li>• Analyze and interpret data such as temperatures in different locations (sun/shade), at different times and different seasons as evidence of how organisms and the environment are influenced by the weather and changing seasons</li> <li>• working in a teacher-led whole group project, enter simple data into a spreadsheet to create a graph of weather data over time</li> <li>• Use data collection tools and measuring devices to gather data</li> </ul>

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	<b>Nature of Science:</b> <ul style="list-style-type: none"><li>• Ask testable questions about weather and the seasons</li><li>• Make predictions, share their thinking, and ask others how they know that organisms and the environment are influenced by the weather and changing seasons</li><li>• Select and use appropriate tools to measure, record and communicate data about the weather</li></ul>
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## **Content Area: Science**

### **Standard: Earth Systems Science**

#### **Prepared Graduate Competencies:**

- Apply the idea that energy has various forms and its transformation occurs in processes that are predictable and explainable
- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

## **First Grade Expectation**

### **Concepts and skills students know include:**

1. The Sun provides heat and light to Earth

#### **Evidence Outcomes**

##### **Students can:**

- a. Investigate, explain and describe that the Sun provides heat and light to Earth
- b. Analyze and interpret temperature data between day (when the sun shines on our area) and night (when the sun does not shine on our area)
- c. Investigate and communicate findings about what happens when you block the sun's light (exploring shadows and temperature changes)

#### **21<sup>st</sup> Century Skills and Readiness Competencies**

##### **Inquiry:**

- What impact does the Sun have on Earth?
- What happens when you block or change the Sun's light?

##### **Applying Science in Society and Using Technology:**

- Recognize that the Sun provides light and heat (energy) for Earth
- Make decisions about activities to do on school grounds based on the light and heat from the sun (i.e. read under a tree to stay cool or avoid the slide when it is too hot from the sun, etc.)
- Read a thermometer and identify it as a tool for measuring heat
- **With teacher guidance, use software or online tools to record and organize information about temperature**

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	<b>Nature of Science:</b> <ul style="list-style-type: none"><li>• Question peers to push for clarity of reasoning as to why they think the Sun provides heat and light to Earth</li></ul>
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## **Content Area: Science**

### **Standard: Earth Systems Science**

#### **Prepared Graduate Competencies:**

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

## **Kindergarten Expectation**

### **Concepts and skills students know include:**

1. Earth materials can be compared and classified

#### **Evidence Outcomes**

##### **Students can:**

- a. Identify and represent similarities and differences such as texture, color, and shape with Earth Materials
- b. Sort, group and classify earth materials based on observations and explorations

#### **21<sup>st</sup> Century Skills and Readiness Competencies**

##### **Inquiry:**

- Are all Earth materials the same?
- How can we use our senses and scientific tools to sort Earth materials?
- What are different types of Earth materials?

##### **Applying Science in Society and Using Technology:**

- Use a variety of tools to observe, analyze, record and compare Earth materials
- Communicate criteria for sorting the Earth materials
- Interpret information about Earth materials represented in pictures, illustrations, and simple charts.

##### **Nature of Science:**

- Question peers and push for understanding on their criteria for sorting Earth materials

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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Prekindergarten Expectation

#### Concepts and skills students know include:

1. Earth materials and objects in the sky have properties and characteristics

#### Evidence Outcomes

##### Students can:

- a. Use senses to gather information about earth materials and objects in the sky
- b. Make simple observations, explanations and generalizations about earth materials and objects in the sky based on real life experiences

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- What are the similarities and differences between various earth materials and objects in the sky?

##### Applying Science in Society and Using Technology:

- Use scientific tools in their investigations and play with materials such as rocks, soil, sand, water

##### Nature of Science:

- Ask testable question based upon discoveries made while playing
- Collect, describe and record information through discussion, drawings and charts

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## Content Area: Science

### Standard: Earth Systems Science

#### Prepared Graduate Competencies:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere and biosphere interact as a complex system

### Prekindergarten Expectation

#### Concepts and skills students know include:

2. Events such as night and day and the seasons have patterns

#### Evidence Outcomes

##### Students can:

- Identify, predict, and extend patterns based on observations and representations of objects in the sky, daily weather, and seasonal changes

#### 21<sup>st</sup> Century Skills and Readiness Competencies

##### Inquiry:

- Why do natural events reoccur in similar patterns?

##### Applying Science in Society and Using Technology:

- Different activities of various animals (including humans) are aligned with daily and seasonal patterns

##### Nature of Science:

- Open to and curiosity about new tasks and challenges (Predisposition to explore and experiment)